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D-R-A-F-T
28 April 1960

ENVIRONMENTAL RESEARCH AND ITS IMPLICATIONS TO THE LONG-RANGE POWER POSITION

Introduction

This paper outlines the importance attached by Soviet science and technology to the study of the physical environment and the implications of comparative Bloc-Free World knowledge of the physical environment of the entire earth, as an element in the power struggle. The paper of necessity is limited to a conceptual and qualitative description of the element since methodology is lacking to develop the necessary quantitative measurements of the rate of progress in the accumulation of physical environmental observational data or a comparative index of Bloc-Free World ability to forecast and predict the occurrence of physical phenomena. However, it is concluded that the element involves a serious disparity of decided disadvantage to the Free World.

The paper is intended to be a diagnosis only. As such it does not claim or imply that Soviet objectives and methods are superior or inferior to those of the Free World in an absolute sense, nor is it implied that the West must adopt Soviet methods to avoid or eliminate the disparity in the knowledge of the physical environment. It is the thesis of this paper that Soviet objectives and methods have evolved into systematic and comprehensive programs of basic physical environment

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which suggests that the Soviets may develop a time advantage in the capability to forecast or prognosticate the occurrence of physical environmental phenomena, whether for economic competition or for military operations.

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I. Disparities in Physical Environmental Research Arising from Soviet Purposefulness in Objectives, Methods and Organization.

The basis of Soviet science rests on the purposefulness and comprehensiveness inherent in dialectical materialism which is defined as "the manifold study of the development, the universal relationship and mutual interdependence of phenomena" provided the essential justification and support for basic research. The application of systematic principles in the formulation of policies for the discovery and development of natural resources, to solve problems associated with the harsh Soviet physical environment, the improvement of land use, the development of virgin areas in regions of precarious climatic conditions was reflected in the early implementation of comprehensive surveying and mapping programs -- topographic, geologic hydro-geologic, geographic, soils

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vegetation, etc. Out of these motivations and policies has emerged a vast, effective scientific structure which has become the envy of more than one scientist -- US and others. It is capable today of undertaking its own increasing data collection programs, adding to it the data collection of other countries and subsequently undertaking the essential processing of data in association with research studies. The implications of the vastness of this structure and the purposefulness of its operation has worried US scientists -- some to a point of disillusionment -- in government and in academic circles because it is unmatched anywhere in the Free World. Directed to the broad objective of evolving increasing mastery over natural forces, the comprehensiveness of communist ideology has also led to the distinctive development and widespread use of the "collective research" method. This method combines a variety of disciplines to bear on a single research problem. Unlike the US where the team method has been developed almost entirely -- and very effectively -- for industrial research, the Soviets apply the method to basic research. As a consequence the combination of directed purposefulness, concentration of attack and large size that gives the Soviets a long-range time advantage in the achievement of their objective -- forecasting or prognosticating the occurrence of natural phenomena, and developing mastery over the forces of nature. Free World science, on the other hand, for its program formulation in basic research depends essentially on the casual motivations of individual scientists engaged in the search for truth, usually within the individual confines of separate disciplines.

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[redacted] would [redacted] follow that given more or less equal forms and levels of weapons development, military superiority would accrue to that nation having superiority in the ability to forecast the behavior of physical environmental phenomena and control nature. That these objectives are important to military applications is made amply clear by Pokrovskiy: "At the root of the development of military technology lie mankind's achievements in the field of understanding the objective laws of nature and in the field of understanding the means of controlling the forces of nature". "Deep scientific foresight is exceptionally important in military affairs."

The task of developing the capability of forecasting and control is conditioned fundamentally by certain unique aspects of physical environmental data. First, unlike many other fields whose data are observed, analyzed and manipulated under laboratory conditions within finite controllable limits, earth science data, by and large, are observable only in vastness of the earth as a whole, where controllable conditions for experimentation are essentially impossible. Second, each point on the

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earth surface, or in space has properties or characteristics that are unique unto itself. In the final analysis, there are no substitutes for the observational data themselves -- they must be observed at each given point. This aspect takes on singular importance to the power struggle when the coverage of observations is limited due to inaccessibility -- physical, as in the case of polar regions, or political, as in the case of the Sino-Soviet Bloc. The goal of all of the earth sciences, therefore, must be the coverage of the whole of the earth, its seas and the atmosphere. An essential objective, therefore, is an ever-increasing collection of data on a world-wide basis. The problem is even more complicated by the needs of the dynamic geophysical sciences which (1) require continuous observations over an interval of time long enough to obtain all representative variations, and (2) synoptic observations, to provide the simultaneity of observation of a dynamic phenomenon over wide portions of the earth. It is readily evident, therefore, that the collection of data on an ever-expanding world-wide basis becomes an essential explicit goal ~~to fulfill communist dialectical materialistic conditions of providing the necessary data~~ in order that (1) analysis may be undertaken, (2) generalizations derived, (3) discoveries of objective laws formulated, and (4) the development of an ability to forecast or predict the occurrence of physical or environmental phenomena be achieved, as implied by Pokrovskiy, to a sophisticated level, comparable to nuclear physics or orbit prediction in astronomy. Because of the vastness of the world-wide coverage problem, the

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development of programs becomes truly monumental in terms of time and space, and accomplishments difficult to measure. Yet the large size of the Soviet research apparatus and their expanding world-wide activities indicates an inexorable march toward this goal. At what point a superiority over the Free World may be achieved it is impossible to state. While this rate of progress relative to the ultimate Soviet objectives is not measurable quantitatively at the present time some indication of initial advancement becomes evident from a survey of communist physical environmental research, first to meet domestic requirements, and second, from the Soviet expansion into world-wide collection of data. In the summary that follows only some of the more significant fields of research are treated for which sufficient data are available to provide some quantitative measure of progress or descriptive illustration of Soviet development toward their goals.

II. Soviet Domestic Development in Physical Environmental Research

A. Geodesy, Mapping

1. USSR. While various programs in surveying and mapping are undertaken by a large number of ministerial or so-called production enterprises their activities are integrated into a uniform program and implemented through unified specifications. Noteworthy is the vertically-integrated development in the Soviet Army of all phases of surveying and mapping activity -- including field parties, all forms of map compilation and production, scientific research and education including the granting of doctorates to military officers. As a result of the heavy investments in education -- including 5-year courses in higher geodesy*, the Soviets are estimated to have developed a roster upwards of 6,000 engineers and technicians engaged

*In the period 1937-1955 at least 42 Doctorates of Technical Sciences in Geodesy were granted. Up to 1955 no such advanced degrees were being granted in the U.S.

in geodesy, photogrammetry and cartography for topographic map production**. In this production the Soviets have made not only a remarkable adaptation of the experience, methods and instruments of the Free World to a mass program but have developed instruments and techniques of their own, including super wide-angle lenses to provide the widest horizon-to-horizon coverage for use in their aerial mapping. As a result, in the space of 4 decades the Soviets completed the coverage of their entire country -- 2 and 1/2 times the size of the US -- at 1:100,000, involving more than 20,000 individual sheets -- an achievement that is still considered incredible by many Free-World map specialists. In comparison the US in twice the span of time has succeeded in completing less than one-half of its area.[1/] While much of the Soviet coverage -- chiefly in Siberia -- does not meet the high standards of the coverage of the more developed areas, the Soviets are now embarked on a program that will extend triangulation into the Siberian and Arctic areas[2/] by the end of the Seven-Year Plan, and topographic mapping is now concentrating on coverage of the entire developed areas of the USSR at 1:25,000, and the more important areas at 1:10,000. Despite the

1/ The Soviet publication, Geodesy and Cartography, No.2, 1959 states that in many aspects Soviet geodesists and cartographers have already surpassed the geodesists and cartographers of the US. Notwithstanding the fact the US is much smaller in area, and environmental conditions are much more favorable, American geodesits and cartographers have covered no more than 40 per cent of their country. The completion of mapping at 1:25,000 and 1:62,500 is aimed for 1973. Soviet geodesits have already covered their country at 1:100,000, and will not fall behind in their large-scale mapping.

2/ The bulk of the effort will be concentrated in regions of Eastern Siberia, the Urals, Far East, and Central Asia. By the end of the Seven Year Plan, i.e. 1965, 80 % of the topographic-geodetic work will be concentrated in the eastern and northern regions

**The US National Scientific Register, as a result of its 1956-58 survey, lists 1,375 classed as Engineers: surveying, mapping and photogrammetry.

fact that some of the European satellites have had a good topographic mapping foundation, the Soviets in 1952 imposed an extension of their own geodetic and topographic mapping system into the European area by forcing a revision of all the national systems. The program is in the final stages of completion.

The Soviets have taken leadership in the development of geodetic gravimetry, which dates back to 1932 when the Soviet Council of Labor and Defense decreed the undertaking of a general gravimetric survey of the entire USSR which would establish a minimum of one observation per 1,000 sq. kms. (22,000 points). It has been of value both as a reconnaissance framework for resources exploration programs, and for the development of unique and original research aimed to simplify the long meridional extent of Soviet mapping. Out of this research, however, the Soviets devised techniques which, if they continue to gain free access to world-wide gravity data of their own and other countries, will give them the means to easily establish geodetic positions in any unsurveyed area in the world without need to resort to triangulation.

2. Communist China. The Chinese appear to have developed their own program, but with an unknown amount of acknowledged Soviet assistance. Progress appears to have been remarkable. Unlike the European Bloc countries, China established its own system of coordinates, Peiping 1954, with vertical control based on the Yellow Sea vertical datum. By the end of 1957 it is claimed that "approximately half of the territory of the country was well provided with modern high precision -- first-order triangulation and high-precision levelling. --- A considerable part of the country had been covered, by the end of the first five-year plan (1953-57), with new state topographic

surveys on a scale of 1:50,000, and 1:100,000." The Chinese plan calls for completion of first-order triangulation in 1961, and for completion of the topographic map of all of China by 1967. These are to consist of coverage at three scale series: 1:25,000 for the more important areas, 1:50,000 for the remainder of the densely populated and economically developed areas; and 1:100,000 of the desert, mountain and high plateau areas. Again similar to the Soviet experience, this map series is being pushed to completion at the expense of omitting some details, for the plan proposes that after the first coverage is completed (1967), the maps will be revised by incorporating greater detail. Personnel employed in this work has increased to over 20,000.

B. Geology

1. USSR.

From a depleted roster of 30 geologists in the Geological Committee, and a total of 150 in all of pre-revolution - tsarn Russia, the number increased by 1936 to 1,690 geologists in the geological survey and 30,000 workers and service personnel, and by 1956 [illegible] 54,000 engineer-technicians* of which 28,000 had advanced degrees, and 350,000 workers and service personnel. Drilling rigs had increased to 10,400 with 13,000 in operation.

In the geological activities of the USSR were staffed by

98 per cent of the USSR was covered by geological mapping at 1:1,000,000, and more than 65 per cent at the larger scales (of which 40 per cent is at 1:200,000 or larger). Nearest comparable US figures on geological map coverage over 80 years of continuous activity amount to about 15 per cent at 1:62,500 or larger, (excluding Alaska and Hawaii) and about 50

*The nearest US figure available for comparison according to the national Scientific Register is 9,514.

per cent at 1:125,000 to 1:250,000. The benefits of such large investments have brought significant benefits which is best epitomized in the high degree of self-sufficiency achieved in raw materials and in the tremendous and rapid industrialization. One brief quantitative illustration of Soviet benefits from its geological achievement programs is provided by recent Soviet revisions in the estimation of world coal reserves. The accepted Soviet proportion has increased from 21 per cent of the world totals to about 50 per cent. Current Soviet geological research is being continued for an intensified search for raw materials under the pressure of diminishing reserves of economic deposits, and expanding requirements of increasingly complex industry.

calls for the compilation of metallogenic maps in three scale categories: general metallogenic of the USSR (1:1,000,000 and smaller); medium-scale prognostic-metallogenic maps of large ore provinces (1:1,000,000 to 1:200,000); and large-scale prognosis maps of individual ore regions (1:200,000 and larger). Some idea of the magnitude of this effort is provided by the fact that in 1959 alone 620 topics were in work by various geological research organizations. The compilation of small- to medium-scale (1:1,000,000 through 1:200,000) prognosis maps of mineral distribution is one of the specific tasks of the Seven-Year Plan. Work on this problem is said to be lightened by the geological mapping that has been done or is underway. By 1965 25 per cent of the geological surveying will be done by geophysical methods: gravimetric, aeromagnetic, seismic, radiometric, electro-exploratory.

2. Communist China. Geologic exploration, similarly to geodetic surveying, has also been given considerable emphasis in the CHICOM progress for the development of the country. The magnitude of the effort is shown by the increase in the number of geologists the last few years, from several hundred to 400,000. There are now three large geologic institutes, 25 technicians, 22 universities with faculties of geology with a total enrollment of 36,700. There are now 21,000 geologists in communist China. Geological exploration is conducted not only by provincial geological administrations (a number of which have their own scientific research institutes), but also by 10 scientific research institutes in the Chinese Academy of

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Sciences, and by a number of units of production ministries. The ambitious topographic mapping discussed previously is being utilized as a base for geological mapping thus greatly facilitating the progress of surveying and providing a sound scientific foundation. This appears reflected in the claimed high rate of geological mapping progress. By 1958 22 per cent was covered at 1:200,000; nearly 7 per cent at scales larger than 1:200,000, and at the end of 1957 13 percent at 1:1,000,000 to 1:500,000.

C. Arctic Research. The development of Soviet Arctic research has played a significant role in the expansion of Soviet physical environmental research from goals designed to meet domestic economic requirements to objectives requiring research on a global scale. Early Soviet Arctic research, dating back to 1921 when Lenin's decree founded the Floating Marine Scientific Institute, was undertaken primarily as a limited effort aimed eventually toward a gradual development of the Soviet economy. But the formulation of plans in 1932 to open up the Northern Sea Route took on the character of a major effort in the development of the Arctic regions. Soviet initial expansion of shipping proved overambitious when a series of mishaps arising from inadequate information on the harsh physical environment culminated in a number of disasters in 1937. The Soviets became confronted with the basic need for reliable forecasting of weather, ice conditions, currents, etc. Realizing again the interrelationships of various phenomena, the Soviets launched into a variety of basic research programs designed to substantially

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broaden the coverage and increase the volume of environmental data. A variety of unique methods were developed to collect the necessary information; research facilities were expanded or new ones established to undertake studies that would improve the forecasting required for reliable shipping operations, and extend the shipping season eventually to six months. Data collection was expanded from coastal Arctic stations deep into the interior of the Arctic Basin. The successful operation of drifting stations was proven by NP-1 in 1937. Aircraft were developed as "flying laboratories," instrumented to make simultaneous weather and ice observations from the coast deep into the interior of the Basin. Instruments were placed on ice-breakers for weather and ice observations, some being detailed explicitly for additional studies of the pack ice. Scientific teams were combined with the operations of flying laboratories, and landed at numerous, otherwise inaccessible areas where observations were made from ocean bottom to the significant elevations in the lower atmosphere. By 1954 the Soviets developed the first of what now has become a series of High Latitude expeditions which combine flying laboratories, mobile research teams, and drift stations to collect the widest range of synoptic observations. Up to the present time 12 air expeditions have been launched, and the ninth drift station is in process of being set up. As a result of this tremendous effort the Soviets boast, and rightfully so, that they have more information on the Arctic Basin than any other nation in the world. They are now devising a television system of ice observation that transmits ice conditions to central points for correlation with other weather information in the preparation of synoptic ice and weather charts.

US research in the Basin did not begin until after World War II. The first drifting station T-3, re-named Bravo, was first occupied in 1952-54, re-occupied briefly in 1955, and again in 1957. Two other drift floe stations were established, the last of which was abandoned in February 1960. The use of submarines initiated by the US, offers unusual opportunities for research, provided that systematic coverage is developed. Another unusual and significant contribution has been the maintenance of daily ice reconnaissance and weather flights conducted over the Basin since about 1947. Thus while the US has outpaced the Soviets in the development of a new method, and has maintained continuity of observations in its daily flights, US programming suffers from a lack of comprehensiveness and continuity. For example while T-3 is still occupied, the equipment from the other two stations is in storage until a requirement authorizes a new launching. Whether submarine work develops into a long-range program is not clear. On balance therefore, in Arctic research the Soviets enjoy a superiority in terms of comprehensiveness of types of research, extent of coverage, and continuity of observations over a longer period of time. This difference illustrates again the fundamental difference in approach between the US and the USSR, for it can be stated categorically that Soviet research is systematic, integrated and planned for indefinite continuity. US Arctic Basin research is

primarily a military activity, subject to the swings of the annual budget cycle and shift in military requirements. While it is true that Soviet activity has direct application to the needs of the Northern Sea Route, the final fact remains that the Soviet program yields physical environmental data which is also utilized by their scientific institutes for Soviet long-range objectives.

D. Soviet Competence in [redacted] Sciences. It would not be enough to merely have a voluminous effort in data collection, if the competence of the work were less than adequate.

in general rates the Soviets very well not only in geology but also in various earth science fields as well.

1. Polar geophysics. The Soviets are world leaders in this field. Their advancement into Antarctic research is comprehensive, primarily to advance their coordinated studies of the earth as a whole.

2. Meteorology. Work in weather and meteorology is competent. Research in weather modification and basic cloud physics has paralleled work done in the West, and the Soviets will strive to develop additional weather control techniques. Extensive control of weather, however, is not expected. Significant advances are expected in Soviet upper-atmosphere and solar-terrestrial relationships.

3. Oceanography. Soviet research has been more extensive than that of other leading nations. The Soviet work is of high quality in polar areas, and in marine biology and marine geology. Over the next decade Soviet forecasting of the thermal structure of the ocean will produce applicable results for increased competence in ice forecasting, for predicting sound range conditions, and for meteorological applications. As yet the Soviets are behind the US in chemical and dynamic oceanography, and instrumentation, although improvements in these can be expected.

4. Seismology. Soviet research is intensive and well supported with adequate facilities. The seismic station network has increased from 20 to over 100 since 1945, and the equipment is excellent. Due to the scope and intensity of Soviet research it is likely that Soviet capabilities in many areas of seismology will exceed those of the US in a few years.

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5. Geomagnetism and Geoelectricity. The Soviets have an extensive research program, including the only non-magnetic research cruises of the Zarya. Soviet earth current research, which surpasses that of any other nation, may already led to significant military applications.

E. Entry into International Programs.

It is significant to stress that Soviet policy had traditionally isolated Soviet earth scientists from foreign contacts, although also as a matter of policy, laid down by Lenin himself, every effort was to be made to capitalize on the best and most advanced of bourgeois

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sciences developments. Hence for most of nearly three decades the Soviets tried to maintain a one-way flow of information. One significant exception to this policy was in early Soviet membership in the International Meteorological Organization and its subsequently sponsored project, the International Polar Year, 1932-33 in which the Soviets participated.

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Whether the Stalin regime was the cause of such isolation or not has not yet been established. In any event, the Soviets made their biggest break with past policy by their decision to participate in the International Geophysical Year Program, and shortly afterward to become members of the International Union of Geodesy and Geophysics. When their program unfolded it developed into one of the most comprehensive and ambitious of all participants. In the field of oceanography its effort, judged by the number of ships, was the largest of all. With the successes of their artificial satellite program the Soviets have made great strides in achieving recognition as equal to the US in many of the fields and superior in some (oceanography, satellite).

Unlike their policy following the IPY when they retreated into the isolation, the Soviet policy revealed itself after the IGY and manifested considerable initiative to secure continued IGY cooperation into the IQSY -- International Geophysical Cooperation, which is now being conducted through various special committees of the International Council of Scientific Unions (ICSU). These

now include Special Committees on Antarctic Research, on Outer Space, and on Oceanography. The Soviets are also members of other international organizations such as the International Geological Congress, the International Astronomical Union, the International Astronautical Federation, and others. In addition, the Soviets have also embarked on a program of exchange of scientists. The major theme is: coordinate programs, and exchange information.

The Soviets from the very beginning undertook programs, particularly in Antarctica, in geology, geography, mapping, resources exploration, air and sea navigation studies, and preparation of pilots. In other words, the Soviet interest was in more than the IGY, and for a much longer duration than the 18-month period of the IGY. It would appear that Soviet world-wide research is here to stay.

F. B. Soviet Aid Programs as a Means of World-Wide Data Collection.

The list of Soviet projects (Figure 5) in the various aid programs includes those which by their nature would be adaptable to the collection of physical environmental data. Whether these projects were intended to be so used is immaterial. Some of the programs are comprehensive geophysical or geological surveys. Other smaller programs are also important for each provides an opportunity to collect unique exploration or mapping data. Another significant though less suspecting activity is the training of indigenous personnel (Iraq) or the construction of educational establishments (Guinea) or research

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institutes (Indonesia). These afford opportunities to ensure among others, two objectives pertinent to future scientific relationships: (1) scientific training in the dogma of dialectical materialism, and (2) training in Soviet methods and techniques. The former ensures another convert to a cult of Soviet science with the erroneous impression that only Soviet science performs on the principles of the scientific method. Such a convert becomes another disciple to the cause and a willing contributor of data to the USSR. With training in Soviet methods and techniques the Soviets ensure prospects for more homogeneity in the data collected.

There are indications that earth scientists may become the "bird dogs" of future aid proposals. This is suggested by the formulation in the USSR in 1959 of a Soviet Association of Friendship and Cultural Cooperation with Latin America. Two of the four vice-presidents selected are outstanding Soviet physical geographers. Designed to interpret Soviet life to Latin America the unusual appointment of geographers suggests their use to establish contacts with geographers, strengthen the flow of geographic data to the USSR, and possibly assist in the formulation of aid programs.

The almost universal inclusion of terrestrial surveys and mapping suggests a Soviet determination to utilize such an inherently systematic approach to the raising of the productive capacities that proved so effective in the USSR. Moreover, such support is invariably given to socially-owned enterprises which to the Soviets promises to lead to eventual communism.

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III. Current and Future Disparities in Knowledge of the Physical Environment

A. Disparities Due to Sino-Soviet Withholding of Information

The comparative status of knowledge concerning the physical environment takes on a unique significance because at any given point or area there is a unique combination of elements and dynamic characteristics which can become known only from studies of observational data. Without these data or with unequal access to these data, knowledge becomes unbalanced, and the disparity can have an ultimate adverse effect on the power relationship. The Sino-Soviet Bloc enjoys certain advantages by virtue of a long-standing policy of withholding a variety of basic environmental information concerning the vast area of the USSR, comprising one-sixth of the earth's surface, plus Communist China with an area larger than that of the US. This a direct consequence of a deliberate policy intended to make secure the national defense of the Soviet Union.

The principal materials withheld include all postwar sheets of the topographic map coverage (1:500,000, 1:300,000, 1:200,000, 1:100,000, 1:50,000, 1:25,000, 1:10,000, and larger) and most of the sheets of even the 1:1,000,000 series; all postwar geodetic catalogs of the latest unified geodetic system, all gravity catalogs, all detailed catalogs of geomagnetism; all geologic map series at scales larger than 1:1,000,000, and all but about one-third of the 1:1,000,000 series. Despite its membership in the International Association of Geodesy, IUGG, the Soviets are

withholding all maps and catalogs, and even withholding information on triangulation and levelling networks. When confronted directly with the request for gravity information, the Soviets resort to the lie in order to evade dissemination. On the basis of information from one aid-recipient country, it is believed that the Soviets attempt to establish comparable security protection over survey data of aid-recipient countries.

While this is being withheld, the Soviet Union, with its vast and elaborate system of collection and processing of foreign information, has probably collected most if not all of the available information on the rest of the world.

Although the IGY was established on the principle of free exchange of information, the fulfillment of this performance is not subject to review. While the Soviets acquired a tremendous amount that is of strategic value much of what they have released has been of prestige value, or of a nature that has no direct military application. None of the materials mentioned above have become available either because the materials predated the IGY or, as in the case of the topographic and geologic maps, and the geodetic and gravity catalogs, they were not substantive parts of the IGY programs. This was explicitly confirmed in 1956 when the Soviet scientists, in a generous gesture of cooperation, disseminated declassified reports on the Arctic. Nevertheless, the sections concerned with gravity and geomagnetic data were cut out. Many of the data released are known to be

given in generalized or processed form and not as raw data. The Soviets were also known to be withholding some of the communications codes of their own satellites, making it impossible to decode the transmitted information. So long as this condition is allowed to continue, the Western World, with its traditional policy of freely exchanging information, will find that the gap of disparity is ever widening and that the Soviets are accruing an increasing advantage in ultimately developing superior knowledge of the physical environment. The assessment of the magnitude and measurable consequences of this disparity has not as yet [redacted] specific subject of study.

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IV. Some Aspects of US Science Problems

Whereas Soviet science from the very beginning of Soviet rule was given a top-level role in the planning of research and development for the national economy, US science through World War II did not perform a comparable function. The service of US science was performed essentially through the National Academy of Sciences - National Research Council on an individual project basis. Basic research was primarily centered in the universities where research is highly individualized in consonance with the traditional role of the university in its search for truth.

In periods of major national crises as in World War II large sums of money were supplied to support military needs. As a result major US advances in the Government's management have come about under the pressure of emergencies. Realization of the inadequacy of this spurt and stagnation led to the establishment of the National Science Foundation in 1949, whose function is to provide Federal assistance in support of basic scientific research. However Soviet earth satellite success in 1957 aroused a "sense of crises" and inquiry which has not yet been finalized, and even now "thoughtful persons differ over the direction we should take "to strengthen the goals and structure of US science and education. Further deficiencies are indicated in the admonitions of the President's Science Advisory Committee report "Strengthening American Science," released December 1958. If Federal support is halting and erratic,

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if it emphasizes mechanism and hardware to the neglect of fundamental understanding --- the net result could be an impoverished science." It advises that "the interplay between fields, producing unexpected results, is at the heart of technical progress (compare with p. 1 -- definition of dialectical materialism). Research programs should have great breadth and scope. Ways must be found to recognize the importance of stability and other long-term goals. Need must be recognized for fully integrated policies to support public and private laboratories. There is a need for the ~~The~~ Federal government ~~should~~ to pull together the policies of differenqt departments to integrate and reconcile them as a whole, and notice the problem of research planning by universities who get extensive support but on a single project basis. Thus one of the functions of the Federal Council for Science and Technology (March 1959) concerning the Nation's overall advancement in science and technology, was "to identify research needs including areas of research requiring additional emphasis, to achieve more effective utilization of the scientific and technological resources and facilities of Federal agencies, and to further international cooperation in science and technology." Yet in the 1959 NSF report Dr. Waterman cautions that less than 8 percent of all research and development funds went into basic research.

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V. Long-Range Prospects

The Sino-Soviet Bloc can be expected to continue its policies of expanding its world wide collection of data on its own and by encouraging international scientific programs to provide additional data for Soviet scientific objectives. At the same time it will continue its anti-liberal policy of withholding as much information as possible, releasing only those data not having sufficient direct military value, as a kind of pay-off to keep international programs from drying up. Soviet physical environmental research, which has demonstrated its effectiveness and gained recognition in its basic contributions to (1) Soviet industrialization and other national economic development, and (2) the support of military operations during the past wars. In the course of these activities communist science has reached a high level of capability and sophistication which now can be used for the broadened phase of world-wide research, and which is essential if communism is to achieve its long-range objectives. Moving out into world-wide research communist serves to fulfill its scientific requirements and at the same time to provide benefits toward the intermediate goals of advancing communism. This is accomplished in two ways: (1) participation in international scientific research, which not only increases the collection of data but also affords an opportunity to show off communist science; and (2) support of Soviet foreign aid programs in underdeveloped areas, which not only provides still another opportunity for data collection but also provides effectiveness to aid programs through basic, systematic resource survey and mapping projects, as proven in the development of underdeveloped bolshevik Russia. International participation further serves communist purposes in the struggle for men's minds by the subterfuge of identifying the effective use of the scientific method exclusively with dialectic materialism as the

only ultimate means for [redacted] human development, while at the same time portraying bourgeois science as ineffective, sterile and employed exclusively in the interest of profiteers and warmongers.

Soviet policy of withholding basic physical environmental data on the one hand, while it reaches out for the freely-given information on the other, places the Communist Bloc in a superior position, since physical environmental data are by their nature unique and distinctive. The inability of the Free World to overcome this disparity in data except by extra-expensive and time-consuming techniques creates a serious time lag which is not likely to be sufficiently overcome for years to come. As a consequence purposeful, dynamic, highly-integrated Soviet physical environmental research could give significant superiority for an extended period of time.

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